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**PORTO RICO AGRICULTURAL EXPERIMENT STATION**  
**MAYAGUEZ, PORTO RICO**

Under the supervision of the  
**UNITED STATES DEPARTMENT OF AGRICULTURE**

**REPORT OF THE PORTO RICO**  
**AGRICULTURAL EXPERIMENT**  
**STATION**

**1931**

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## PORTO RICO AGRICULTURAL EXPERIMENT STATION, MAYAGUEZ

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

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# PORTO RICO AGRICULTURAL EXPERIMENT STATION

## MAYAGUEZ, P. R.

Under the supervision of the  
UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D. C.

May, 1932

## REPORT OF THE PORTO RICO AGRICULTURAL EXPERIMENT STATION, 1931

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### REPORT OF THE DIRECTOR

By T. B. McCLELLAND

The year covered by this report was one of economic struggle for the Porto Rican farmer, who received decreased prices for all his major products. The present unstable economic conditions require the farmer to practice greater diversification than he has practiced in the past. By so doing he can at least get most of his food from his own farm, and thus carry on during the depression.

The work of the station for the fiscal year 1930-31 was begun under the direction of George F. Freeman, who died September 17, 1930. The present director was appointed October 1, 1930. No other changes were made in the station staff. Three major positions on the staff are now unfilled. Furthermore, the horticultural work, formerly in charge of two members of the staff, is carried by the director. Because of the greatly depleted staff, the station is prevented from conducting many lines of investigation for which there is urgent need.

The station work is grouped under 26 projects, of which 7 deal either with livestock or with animal or poultry parasites, 4 with sugarcane, 3 each with citrus fruits and coffee, 2 each with pineapples, corn, and vegetables, and 1 each with avocados, mangoes, and exotic plants.

The parasitologist made a general survey of the more important parasites of domestic animals and spent much time studying the life histories and intermediate hosts of parasites in Porto Rico.

Sugarcane breeding yielded inbred seedlings and new hybrid progeny of promise. Most of the seedlings that resulted from crossing Mayaguez 28 and P. O. J. 2878 are highly resistant to mosaic, and some of them show pronounced resistance to drought. A number of these seedlings appear to be of decided promise as indicated by their vigorous growth in the second year. Of the seedlings that have now been under test for five years or longer, Mayaguez Nos. 7, 28, 42, and 63 have been found to be of particular promise. All centrals at which cooperative trials of Mayaguez seedlings have been made have increased the area planted to these seedlings for more extensive trials, and it is estimated that more than 600 acres of Mayaguez seedlings will be harvested in 1933.

Both the assistant chemist and the plant breeder devoted considerable time to a study of cane variety P. O. J. 2878. Data were obtained on growth and production and on quality of juice. Growth was highly satisfactory, generally exceeding the commercial variety B. H. 10/12 in tonnage where the varieties were planted in comparative-test plats. A disadvantageous characteristic of P. O. J. 2878 is that of uprooting easily under moderately strong wind. The juice, on analysis, showed considerable variation, but had a general tendency toward higher sucrose and purity than did the juice of canes B. H. 10/12, S. C. 12/4, and P. O. J. 2725 grown on adjacent plats. Defecation was irregular, the solids sometimes showing considerable retardation in settling when the juice was low in phosphoric acid. Juice that was high in phosphoric acid gave no trouble in defecation. It is planned to continue these studies.

Sweet-corn breeding was continued with the object of obtaining more vigorous growth and an improved type of kernel. Tests were made with field corn in eight localities in cooperation with the insular department of agriculture.

The work with citrus was mainly along three lines. Studies of root development showed the feeding roots in clay soil to be confined principally to the upper 8 inches. Drought damage demonstrated the necessity for irrigation in certain districts where citrus plantations are located, and irrigation facilities are being supplied on some of the plantations. The water-holding capacity of several of the soils in which citrus is growing was investigated by the agriculturist. Such of the second-generation grapefruit seedlings of the Duncan-Triumph cross as showed no scab infection were transplanted in the autumn from the nursery rows to permanent location for further observation.

Pineapple plants were treated with various chemicals in an effort to control the time of blooming, but without any apparent effect.

A chemical method was developed for determining in the leaves of the bay tree (*Amomis caryophyllata*; *Pimenta acris*) the presence or absence of the lemon scent which is objectionable to distillers of bay oil, even when it is present to a very slight degree.

Publications during the year included a bulletin in the Spanish language on citrus culture,<sup>1</sup> seven numbers of Agricultural Notes

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<sup>1</sup> HENRICKSEN, H. C. EL CULTIVO DE LAS FRUTAS CITROSAS EN PUERTO RICO. Porto Rico Agr. Expt. Sta. Bul. 33, 34 p., illus. 1931. (Spanish edition.)

giving timely information on miscellaneous subjects under investigation at the station,<sup>2</sup> and the results of a study of the use of fertilizers for the coconut palm.<sup>3</sup>

#### COOPERATIVE WORK

In carrying on experimental work, the station has met with hearty cooperation from island planters, corporations, and insular officials. This cooperation has been maintained principally with the sugarcane crop which needs to be grown much more extensively than the station facilities permit. In most instances the station prepares the plans for making the plantings, furnishes the plant material, collects information on the work in progress, and helps to supervise both planting and harvesting. Those cooperating with the station furnish the land, the labor, and the requisite laboratory facilities, and help to supervise the work and to collect information on its progress. The Centrals Aguirre, Coloso, Eureka, and Fajardo, and Luis Fajardo and Russell & Co., have thus cooperated with the station on areas aggregating 30 acres at Anasco, Hormigueros, Guayama, Santa Isabel, Isabela, Coloso, and Fajardo. The insular department of agriculture has collaborated with the station in cornbreeding work on areas of 4½ acres at Isabela, 3 acres at Utuado, 1 acre at Barranquitas, and 1 acre at Rio Piedras. Messrs. Avery, Fletcher, Stevenson and Raymer, and Murphy and Clark have cooperated with the station in citrus and pineapple investigations on the respective plantations under their management. Alfredo Lopez at Las Vegas has cooperated with the station in work with coffee.

#### BUILDINGS AND IMPROVEMENTS

A greenhouse, 25 by 50 feet, was purchased and the site prepared for its erection. This building will be larger and of more substantial construction than the greenhouse destroyed by the hurricane of September, 1928. A greenhouse is needed in the Tropics in experimental work and in plant propagation to provide protection against the heavy and repeated downpours of the rainy season. A concrete box was constructed for use in the partial sterilization of soil by steam. Repairs to roads and buildings left the station plant in better condition than before.

#### DRAINAGE AND IRRIGATION

In the region of Porto Rico in which the station is situated the rainfall is often overabundant during five or six months, and deficient for an equal length of time. The heavy rainfall of summer and autumn causes the lowlands, including the greater part of the cultivated lands of the station, to become swampy unless adequately drained. In the dry season, however, the drought is often so severe that seeds will remain unsprouted in the ground for weeks, or, if they sprout, the resultant plants will make only feeble growth and small yield. Such alternations of swamp and desert conditions make adequate drainage and irrigation facilities necessary. The station lands have been greatly improved in both respects.

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<sup>2</sup> Available mimeographed copies of these may be had upon application to the director of the station.

<sup>3</sup> MCCLELLAND, T. B. EXPERIMENTS WITH FERTILIZERS ON COCONUT PALMS AND VARIATION IN PALM PRODUCTIVITY. Porto Rico Agr. Expt. Sta. Bul. 34, 23 p., illus. 1931.

A new main drainage ditch was dug and lined with concrete for more than 500 feet of its length. The floor of the concrete-lined



FIGURE 1.—Construction of dam: A.—Central concrete core completed. Puddling the earth at the side by dumping it into water. B.—Completing the embankment over the concrete core. Viewed from within the reservoir

section is 3 feet wide, the sloping sides are 3 feet 8 inches wide at the beginning of the ditch and 9 feet wide at the outlet, measuring from ditch floor to ground level, and the span at the surface increases from

7½ to 10 feet. This ditch greatly facilitates the rapid delivery into the river of water from the main tract of flat land.

A group of valleys has long furnished some water for irrigation of the lower plain. The water from two small springs and that which drains from 20 or more acres of land escapes through a single channel and in the past was sufficient to irrigate only a small area. The brick canal which had carried the water for 20 years or more had worn considerably, and as a result much of the limited supply was lost en route. A dam was therefore built across the mouth of the lower valley to increase the available water supply. This was of very substantial construction to assure permanency, since high floods rush through the valley in time of heavy rain. A con-



FIGURE 2.—The reservoir photographed from the embankment. Much of the area under water is concealed by the high grass at the right, still alive although standing in water

crete core, for the greater part of its length 12 to 15 inches thick at the base, and tapering to a thickness of 6 to 10 inches above, was made and broadly banked with earth. The earth was puddled on both sides of the core. (Fig. 1.) The chassis of 14 old, discarded automobiles were used to reinforce the core. The concrete construction was carried 1 foot above the line of flow, and the earth embankment was built a foot higher. Provision was made for raising the height of the dam in the event that this should be desirable. This dam has transformed a small reservoir into a larger one, the maximum depth now being over 6 feet and the area under water approximately 1¼ acres of land. The reservoir is filled and overflowing at present. (Fig 2.)

The old irrigation canal about 1,200 feet in length, which brought the water to the margin of the cultivated land, was reconstructed. A new concrete extension of the canal, about 675 feet, was built to carry

the water into the center of the cultivated plain. A considerable area of land not previously under irrigation can now be utilized during the dry season for crops that could not otherwise be grown there successfully.

#### CROTALARIAS

Two distinct strains of *Crotalaria striata* have been grown at the station. One of them has large leaves and makes rank, tall growth. The other has smaller leaves and develops into a smaller plant. The former at times has been referred to as the large-leaved kind, and the latter both as the small-leaved form and as *C. saltiana*. Hereafter these will be termed *C. striata* major and *C. striata* minor, respectively, to differentiate them. (Fig. 3, A.) The latter is the strain widely grown in Porto Rico in the citrus plantations and to produce seed for export. The greater size attained by *C. striata* major recommends it for replacing *C. striata* minor where either wind protection or the production of organic matter is the object sought. (Fig. 3, B.)

*Crotalaria juncea* and *C. usaramoensis* should be more widely grown locally than they are. Under some conditions both are superior to *C. striata* minor. Of all the Crotalarias tested at the station, *C. juncea* makes the most growth in the least time and is the most successful in competing with encroaching weeds. Planted in a well-prepared seed bed, it will take care of itself without further attention. *C. usaramoensis*, however, grows slowly when young and therefore has to struggle with weeds. The weed growth on an untouched field of *C. usaramoensis* may be so heavy at six weeks from time of seeding the latter that the Crotalaria can be found only on close inspection. Once established, however, *C. usaramoensis* furnishes a good cover crop for a longer time than does *C. juncea*.

Seeds of different species of Crotalarias were distributed.

#### COFFEE

During the year the work on coffee progressed satisfactorily. Plants, set in the plats for testing the nitrogen-potash ratio for guidance in fertilizer practice, grew well. They were lightly and uniformly fertilized to aid them in becoming established before the beginning of the differentiation in treatment.

In the fertilizer tests at Las Vegas, the two plats that had received the greater amounts of potash led in yield, and all completely fertilized plats surpassed the check plat. It was notable that plat No. 4, which from the beginning of the recorded yields in 1916 to 1927, inclusive, was easily the poorest plat in the experiment, gave the highest production in two of the last three crops, and also in the three crops considered as a unit. It produced this year at the acre rate of 788 pounds of parchment-free coffee, the maximum of all plats, in contrast with a 338-pound production on the check plat. Prior to the crop in 1926, plat No. 4 had received nitrogen only. Since then it has received semiannual applications at the acre rate of 150 pounds each of sodium nitrate, superphosphate, and potassium sulphate.

The pronounced effect of potash on growth of coffee may be seen in various plats in the station south field, where fertilizer tests have been in progress for 17 years. Figure 4 shows trees that have received

similar amounts of nitrogen. Those on the right have received potash, whereas those on the left have not.



FIGURE 3.—Development of *Crotalaria striata*: A.—*C. striata* minor, left, and *C. striata* major, right, planted November, 1930, and photographed May 8, 1931. The men in the picture are of equal height. B.—*C. striata* major planted November, 1930, photographed in July, 1931

Coffee seeds and more than 70,000 seeds of *Gliricidia sepium* to furnish shade trees for coffee were distributed to planters.

## AVOCADOS

The immediate vicinity of Mayaguez is not suited to commercial plantings of avocados because of the presence in the soil of *Phytophthora* root disease, favored by the protracted rainy season. The drier districts to the north and the south are far more favorable for the development of commercial plantings of avocados. In 1926, 26 trees of Guatemalan avocado varieties, grafted at the station, were given to a planter for trial near Rincon. Four of the trees carried fruit at the time of the hurricane two years later. Despite very severe hurricane damage, 14 of the trees survived; and of these 6 fruited this season. The owner reported that fruit from them brought about \$60 on the island. The appearance of the trees indicates that much



FIGURE 4.—Difference in growth of heavily fertilized coffee due to a difference in kind of fertilizer applied. The trees at the right have received potassium sulphate, whereas those on the left have received no potash. Both groups have received equal amounts of ammonium sulphate

more may be expected of them next season. Four years after they were planted, the best developed trees measured 12 to 15 feet in spread and almost as much in height.

## MANGOES

More than 2,000 seedlings of the Chinese mango, Cambodiana, were distributed. The seedlings of this excellent variety come sufficiently true to type to warrant its general propagation by seed.

## LEGUMES

A planting was made of selections from bean (*Phaseolus vulgaris*) crosses at the season generally most favorable for growth and production. Drought followed planting and so delayed both germination and growth that the crop was small and was caught by the heavy

rains before it had a chance to mature. Several of the Temperate Zone standard garden varieties were grown for comparison with the selections. The difference in leaf-hopper damage to the two groups was pronounced, as was shown by the contrast between the uniformly deep green color of the selections carrying "blood" of the Caribbean varieties and the very yellow foliage of the Temperate Zone varieties.

A number of strains of East Indian pigeon peas (*Cajanus indicus*), received through the Hawaii Agricultural Experiment Station, were given a preliminary test. The stand was too imperfect for satisfactory comparisons with the local strains with which alternate rows were planted. Some of the imported strains, however, appeared to be promising, as they were highly productive. A second planting was made for further comparison.

#### DASHEENS, TAROS, YAUTIAS, AND YAMS

Dasheens, taros, and yautias were fertilized with 2 to 3 ounces per plant (approximately 600 pounds to 900 pounds per acre) of fertilizer mixtures, without filler, containing two of the elements nitrogen, phosphorus, and potash, or the three in combination. The resultant crop failed to show significant differences that could be attributed to fertilizer treatment. In the planting for the next crop, the amount of fertilizer was doubled, and, as an additional treatment, stable manure alone was applied for comparison with the mineral-fertilizer treatments.

Selections of yams (*Dioscorea* spp.) are being tested for range of productivity. For the several years during which this work has been in progress some strains have remained consistently high or consistently low in production, whereas others have shown no correlation between the production of one year and that of the following, low yields resulting from seed pieces from plants of high production, and vice versa.

More than 300 packages of tubers of taros, dasheens, yautias, and yams were distributed for planting.

#### REPORT OF THE ASSISTANT CHEMIST

By J. O. CARRERO

##### STUDY OF SUGARCANE VARIETY P. O. J. 2878

During the 1930-31 cane-grinding season the recently introduced sugarcane variety P. O. J. 2878 was for the first time ground to a fairly large extent in Porto Rico, and it was decided to obtain comparative data on this variety and the already well-established varieties. (Fig. 5.) In order to find time for the work, studies on the decomposition of cane tops and trash, in progress for some years, were temporarily discontinued. The Central Coloso, where a large amount of P. O. J. 2878 cane was to be harvested, was found to be a favorable place for obtaining part of the data needed, and the cooperation of the central was therefore secured. P. O. J. 2878 was being grown with other varieties in different parts of its holdings. The station was thus enabled to obtain comparative data on juices from different cane varieties growing under similar conditions of soil and fertilizer and to use these data in a further comparison with data from different localities or from different soils. Every

juice sample analyzed was representative of several tons of cane from a field or plat rather than the few pounds ordinarily furnished for laboratory sampling. Juices from different cane varieties and from different districts were examined, the Brix, sucrose, and purity values being determined by the Central laboratory staff, and the reducing sugars, phosphoric acid, and potash content by the station.

Grinding was begun in the last week of November, 1930. Despite the earliness of the date, P. O. J. 2878 yielded juice with high sucrose and purity. The purity of the juices averaged around 84 per cent and often ranged as high as 87 per cent, whereas B. H. 10/12, S. C. 12/4, and P. O. J. 2725 canes ground at the same time yielded juices of lower sucrose and purity, occasionally rising to 80 per cent, but more often falling to 77 and 78 per cent. These data apply in



FIGURE 5.—Sugarcane varieties P. O. J. 2878, on the left, and B. H. 10/12, on the right, 15 months after they were planted. Photographed December 10, 1930

particular to Villanueva district No. 1, plat 32, and to Milagros district No. 3, plat 17, of the Central Coloso. Canes from Maizal district No. 2, plat 27, yielded juices low in sucrose and purity, irrespective of the variety.

The difference between the reducing-sugar contents of the juices of the different varieties was slight as long as the percentage of purity was close. The reducing-sugar content varied with the purity of the juice, being 1 per cent or less with a purity of 85 or above, but this value increased gradually as the purity decreased, so that juices with a purity of 78 to 80 per cent yielded a reducing-sugar content of 2 per cent or over. These values held for every variety analyzed so that once the purity of a juice was known its reducing-sugar content could be estimated within 0.15 to 0.2 per cent of its true value. The determination of the reducing-sugar content was not considered to be of special significance in the examination of the juices.

## PHOSPHORIC ACID IN SUGARCANE

Lately the amount of phosphoric acid present in cane juices has received considerable attention as a probable indication of behavior on defecation. Juices were analyzed for their phosphoric acid content. The method of Springer and Davies<sup>4</sup> by which straight determination of phosphoric acid in the juices can be made, was tried first. It gave good results as long as the phosphoric acid content of the juices was over 15 milligrams per 100 cubic centimeters, but results were not reliable when the content dropped to 15 milligrams or less per 100 cubic centimeters. A more reliable method was needed, and it was decided to obtain a preliminary precipitation and separation of the phosphoric acid before making the final separation with ammonium molybdate. Magnesium and aluminum salts were tried, and finally aluminum sulphate was chosen for making the preliminary separation. The modification was thoroughly tested with different juices of high and low phosphoric acid content and with juices to which small amounts of chemically pure phosphates had been added. The tests yielded closely concordant results. The method is slightly longer than the straight molybdate or the uranium-acetate method, but is thought to be more reliable and accurate than the latter with juices of low phosphoric acid content, and it has the advantage that a larger sample can be used for analysis.

The method employed was as follows: A solution of aluminum sulphate was prepared of such strength that 5 cubic centimeters contained enough aluminum to precipitate 100 milligrams of phosphoric acid. This amount was chosen because the highest value ever obtained at the laboratory was that with a Uba cane containing 96 milligrams of total phosphoric acid per 100 cubic centimeters. As a 50-cubic centimeter sample was analyzed, the amount of aluminum sulphate added was sufficient for a phosphoric acid content of 200 milligrams per 100 cubic centimeters. Five cubic centimeters of the aluminum sulphate solution was added to a 50-cubic centimeter sample of the juice. The whole was thoroughly mixed and heated to boiling, at which time it was made alkaline with ammonium hydroxide. The mixture was boiled for one or two minutes and filtered under vacuum. When care was taken in the filtration the filtrate was clear, showing no trace of cloudiness. The precipitate was washed with a cold dilute solution of ammonium hydroxide and dissolved in dilute nitric acid, and the filter paper was washed with hot water. The acid solution and washings were evaporated to 40 to 50 cubic centimeters, when they were made alkaline with ammonium hydroxide and again barely acid with nitric acid, after which the phosphoric acid was precipitated with ammonium molybdate.

While the new modification was under test for reliability, observation showed striking differences in results from the use of different methods. The first tests were made at Coloso early in December, 1930, and the final tests were made at Mayaguez in February and in March, 1931. The juices were analyzed by the Springer and Davies<sup>5</sup> method, by the new modification, and by a commonly used

<sup>4</sup> SPRINGER, H. B., and DAVIES, J. G. [THE CHEMIST'S CORNER.] DETERMINATION OF PHOSPHATES IN SUGARCANE JUICE. Sugar [New York] 29:335. 1927. Also Jour. Soc. Chem. Indus. 46:143T-144T. 1927.

<sup>5</sup> SPRINGER, H. B., and DAVIES, J. G. Op. cit. (See footnote 4.)

method in which sucrose and organic matter were destroyed before the determination of the phosphoric acid. The Springer and Davies method and the new modification gave closely concordant results, but the phosphoric acid shown by these methods amounted to only 48 to 55 per cent of that obtained when sugar and organic matter were first destroyed. Each of a number of tests made at Mayaguez brought out the fact that phosphorus as phosphoric acid in cane juices is only approximately 50 per cent of the total phosphorus present. Apparently the determination of total phosphorus is valueless, only that amount present in the juice as phosphoric acid being the deciding factor in efficient defecation. Keane and Hill<sup>6</sup>, using an entirely different procedure, arrived at the same conclusion.

Phosphoric acid determinations at Coloso and at Mayaguez showed striking differences in results with cane from different regions. Variety P. O. J. 2878 from Coloso districts Nos. 1 and 3, with high sucrose and purity, never showed less than 31 milligrams and often as much as 45 milligrams of phosphoric acid per 100 cubic centimeters of juice, and 50 to 65 milligrams of total phosphorus, whereas varieties B. H. 10/12, S. C. 12/4, and P. O. J. 2725 from the same districts gave only 15 to 24 milligrams of phosphoric acid per 100 cubic centimeters. Juices from Coloso district No. 2, with low sucrose and purity, showed a remarkable drop in phosphoric acid. The content was only 9 to 15 milligrams per 100 cubic centimeters of juice for P. O. J. 2878, whereas for the other varieties it was 6 to 10 milligrams. Since all the varieties received similar treatment the differences in results were ascribed to differences in the soils in which the canes grew. Apparently the availability of phosphorus in the soil varies considerably in different localities. To test this point, the juices of varieties P. O. J. 2878 and B. H. 10/12, and occasionally those of S. C. 12/4 and P. O. J. 2725, from different regions of the island, from Vega Baja on the north coast to Guayama in the south, were analyzed at Mayaguez.

The results of the analyses indicated that the localities from which the canes were derived could be grouped according to the total content of phosphorus in the juice. Expressed in milligrams per 100 cubic centimeters of juice, the results were, for group 1, from Aguadilla-Isabela, 8 to 14; for group 2, from Central Carmen at Vega Baja, Finca Garroci at Anasco, and Central Aguirre at Guayama, 12 to 26; for group 3, from Finca Zeno at Guayanilla, 37 to 48, and from Filial Amor at San German, 38 to 52; for group 4, from Central San Vicente at Vega Baja, 38 to 63, and from Central Fortuna at Ponce, 26 to 68; and for group 5, from Finca Bahr at Lajas, 58 to 84, and from Central Eureka at San German, 45 to 90.

Despite the striking differences in phosphoric acid content in the same variety when grown in different regions, P. O. J. 2878 cane juices showed a higher phosphoric acid content than the other varieties. This increase generally was from 50 to 100 per cent, and occasionally was even greater. Even when B. H. 10/12 juices from Central Eureka had the highest phosphate content, 45 milligrams per 100 cubic centimeters, P. O. J. 2878 juices had 84 to 90 milligrams.

<sup>6</sup> KEANE, J. C., and HILL, H. G. FILTERABILITY OF RAW CANE SUGARS. I. EFFECT OF VARIOUS FACTORS PRIOR TO PAN-BOILING. II. EFFECT OF PAN-BOILING OPERATIONS. *Indus. and Engin. Chem.* 23: 421-427 1931.

Thus, either P. O. J. 2878 has greater need of phosphorus for its development, or the soil phosphorus is more readily available to that variety than to the others. Analyses of tops and trash of the different varieties and from different localities failed to show the striking differences shown by the juices. In fact, even with a difference of 100 per cent in the phosphoric acid content of the juices of the different varieties, the percentage in their tops and trash was the same. The only exception to this was at Central Eureka, where P. O. J. 2878 tops had 50 per cent more than B. H. 10/12 tops, whereas the trash, which ordinarily had only 50 per cent as much phosphoric acid as the tops, had almost as much as tops from other regions.

## REPORT OF THE PLANT BREEDER

By R. L. DAVIS

### SUGARCANE

First-year, second-year, and third-year seedlings of sugarcane were propagated and tested at Mayaguez, cooperative trials of imported varieties were made, and preliminary field trials of sixth-year and seventh-year seedlings were carried on in cooperation with sugar centrals in various parts of the island. Experiments were also made in the use of the hand refractometer for analyzing first-year seedlings, and on methods of preserving cane for exhibition and for planting. Seed of Mayaguez varieties was distributed, and a survey was made to determine the area under cultivation with the recently distributed varieties.

### BREEDING

*First-year seedlings.*—Inadequate rainfall during the year prevented the cane in the breeding plats on Las Mesas from arrowing freely. Conditions were favorable at Paraiso, where breeding plats were maintained in cooperation with Central Fajardo, and over 400 seedlings of B-6835. Some 400 inbred seedlings of U. S. 785 were arrows supplied to the station. The prolific stooling of a number of these seedlings indicates that they are hybrids and not self-pollinated seedlings of B-6835. Some 400 inbred seedlings of U. S. 785 were secured from Las Mesas with a view to securing for breeding stock a prolific high-sucrose variety that would be immune to the mosaic disease.

The crosses between P. O. J. 2725 and the inbred Kassoer seedlings U. S. 785 and U. S. 541 demonstrated the value of self-pollination work in sugarcane. Satisfactory sucrose analyses were secured from seedlings of both combinations that ranged nearly as high as 18 per cent. The analyses compare well with those of first-year seedlings of "noble" canes grown under similar conditions. U. S. 541 has very thin canes, is semierect, and has tightly clasping leaves. U. S. 785 has canes of medium to small girth, grows erect, and has leaves that cling slightly. These contrasting characters were transmitted to the respective progenies. Where U. S. 785 was the staminate parent, a large proportion of the progeny was erect and shed leaves freely, whereas the reverse was true where U. S. 541 was the staminate parent. The cane girths were definitely greater among the progeny

pollinated by U. S. 785 than among those pollinated by U. S. 541.

The other first-year seedlings propagated in 1930 were cut for seed and planted when 8 to 9 months old. This practice is desirable where, as at Mayaguez, irrigation water is inadequate for propagation purposes in the early spring months.

*Second-year seedlings.*—The seedlings of U. S. 541, pollinated with S. C. 12/4, proved to be highly resistant to mosaic. Several seedlings of P. O. J. 2725 and B. H. 10/12 also appear to be mosaic-resistant. The outstanding progeny of the second-year seedlings is that of Mayaguez 28 and P. O. J. 2878. Of 25 seedlings of this combination under trial, only one appears to be very susceptible, and the majority are resistant to mosaic. Interplanted with rows of P. O. J. 2878, several of these seedlings were found to equal them in prolificacy. A strong contrast in drought resistance was shown. In several places the leaves of P. O. J. 2878 suffered severely, whereas those of the adjoining seedlings remained green and healthy throughout the dry season.

*Second-year and third-year seedlings of P. O. J. 2364 and Mayaguez 9.*—Notes taken on the first ratoons in the mosaic-elimination plat of the seedlings of P. O. J. 2364 and Mayaguez 9 confirm the findings of the preceding year and indicate that most of the 71 seedlings under trial are highly resistant or apparently immune to mosaic. In February, 1931, satisfactory analyses of hand-milled juices from 12½-months-old spring-planted, or "primavera," canes were made. Of 9 seedlings, Mayaguez 151 stood lowest on analysis, having 15.51 per cent sucrose and a purity of 83 per cent. Descriptions of 20 of these seedlings were recorded, and emphasis was placed on the use of the striation of the internodes as one means of identification.

Third-year fall-planted, or "gran cultura," trials of some of the more promising seedlings of Mayaguez 9 and P. O. J. 2364 were begun. A study of several hundred stools again indicated that several seedlings of this series compare well with P. O. J. 2878 in stooling habit. The areas used in the experiment varied from one-twentieth to one-fortieth of an acre to permit the grinding of a ton or more of each seedling per plat in 1932.

*Cooperative trials with sixth-year and seventh-year seedlings.*—Preliminary field trials on Mayaguez sixth-year and seventh-year seedlings were made in cooperation with Centrals Coloso, Fajardo, Aguirre, and Eureka, and with Russell & Co., at Santa Rita, Filial Amor, and Constancia. Owing to an inadequate supply of cuttings, only two replications of each variety were made in each locality. Table 1 shows that 10 Mayaguez seedlings exceeded B. H. 10/12 in tons of cane per acre, 9 of them by a distinct margin.

Seedlings Nos. 13, 44, 49, 52, 61, and 83 were planted in one locality only, and the results indicated merely that these varieties might be tried more extensively. The four seedlings Nos. 3, 7, 42, and 63 were tested in two or more localities. Of these seedlings, Mayaguez 42 apparently had the highest sucrose content, its estimated sugar yield in percentage of cane weight being equal to that of B. H. 10/12 at Fajardo and at Constancia, and somewhat lower than that of B. H. 10/12 at Aguirre. Mayaguez seedlings Nos. 3 and 7 were both lower than B. H. 10/12 in estimated sugar yield. Mayaguez 63 equaled

B. H. 10/12 in estimated sugar yield at Aguirre, but results of previous analyses at Mayaguez indicated the former to be inferior to Mayaguez 42 in this respect. The outstanding variety for cane production, however, was Mayaguez 63, which averaged 87.2 tons per acre for the two gran cultura trials at Filial Amor and at Aguirre, an advantage of 25 tons over adjoining plats of B. H. 10/12. Mayaguez 42 led B. H. 10/12 by a margin of 15 tons of cane at Aguirre and 11 tons at Fajardo. In both trials Mayaguez 3 was inferior to Mayaguez 42 in cane tonnage and in sucrose.

TABLE 1.—*Estimated yields of cane in cooperative preliminary field trials with Centrals Aguirre and Fajardo, and with Russell & Co.*

Place of growth, age of plant, and variety	Yield of cane per acre <sup>1</sup>	Estimated proportion of sugar <sup>2</sup>	Estimated yield of sugar per acre <sup>3</sup>
Aguirre: Gran cultura plantings			
17 months old:	<i>Tons</i>	<i>Per cent</i>	<i>Tons</i>
Mayaguez 7.....	74.00	10.31	7.63
B. H. 10/12.....	57.30	13.47	7.71
Mayaguez 42.....	77.80	11.78	9.15
B. H. 10/12.....	62.60	13.14	8.23
Mayaguez 3.....	58.35	11.97	6.98
B. H. 10/12.....	47.40	14.61	6.93
Mayaguez 63.....	92.80	12.90	11.52
B. H. 10/12.....	65.40	12.27	8.44
Fajardo: Primavera plantings			
15 months old:			
Mayaguez 42.....	69.35	13.55	9.36
B. H. 10/12.....	58.30	13.55	7.90
Mayaguez 3.....	64.85	12.15	7.86
B. H. 10/12.....	56.70	13.40	7.60
Filial Amor: Gran cultura plantings			
18½ months old:			
Mayaguez 7.....	(4)	(4)	(4)
Mayaguez 42.....	(4)	(4)	(4)
Mayaguez 3.....	60.50	14.10	8.57
B. H. 10/12.....	54.50	11.30	6.16
Mayaguez 63.....	81.60		
B. H. 10/12.....	59.00		
Mayaguez 49.....	89.50	15.45	13.81
B. H. 10/12.....	63.20	14.53	9.23
Constancia: Primavera plantings			
15 months old:			
Mayaguez 7.....	46.90	14.25	6.68
B. H. 10/12.....	39.20	15.47	6.17
Mayaguez 42.....	47.70	15.01	7.32
B. H. 10/12.....	44.70	15.14	6.77
Mayaguez 13.....	49.10	15.56	7.76
B. H. 10/12.....	40.90	16.14	6.61
Mayaguez 44.....	46.60	15.57	7.25
B. H. 10/12.....	56.60	12.61	6.97
Mayaguez 61.....	59.30	14.40	8.55
B. H. 10/12.....	50.40	14.28	7.18
Mayaguez 83.....	57.50		
B. H. 10/12.....	38.30		
Santa Rita: Primavera plantings			
14½ months old:			
Mayaguez 52.....	57.50	12.92	7.44
B. H. 10/12.....	54.15	12.37	6.70

<sup>1</sup> Plat areas varied from one-fortieth to one-sixtieth of an acre. Each entry is the average for two such plats. The data from the adjoining two plats of B. H. 10/12 are given below that of each seedling for direct comparison.

<sup>2</sup> Sugar yields are based on analyses of hand-milled juices of 30 to 60 canes for each variety.

<sup>3</sup> Sugar production is based on an assumed extraction of 80 per cent.

<sup>4</sup> Cut for seed.

Mayaguez 7 appeared at a marked disadvantage in sucrose content at Aguirre, apparently because of an unfavorable location, as the sucrose of B. H. 10/12 was markedly lower in that part of the field than elsewhere. Mayaguez 7 is a cane of exceptional vigor and is strongly resistant to drought. It is decidedly worthy of more

extensive trial. The superior stooling habit of Mayaguez 7 in comparison with that of S. C. 12/4, its staminate parent, is shown in Figure 6.



FIGURE 6.—Superiority of Mayaguez 7 to S. C. 12/4 in stooling habit and mosaic resistance, Central Eureka. Gran cultura cane 8½-months-old typical stools at the ends of 100-foot rows of cane. Left, Mayaguez 7 is apparently immune to mosaic, germinates far better than B. H. 10/12 under conditions of drought, and exceeds both B. H. 10/12 and S. C. 12/4 in number of shoots per stool. Right, S. C. 12/4 is 8 feet 6 inches tall. Mosaic infection in Mayaguez 7 was nil, whereas in the adjoining row of S. C. 12/4 it was 38.5 per cent. Photographed in July, 1930

Table 2 shows normal-juice analyses and calculated yields, secured in cooperation with Central Coloso, of 13-months-old primavera plantings of cane that was harvested in May, 1931.

TABLE 2.—*Normal-juice analyses and calculated yields of four varieties of cane at Coloso*

Variety	Quantity of cane ground	Sucrose	Purity	Proportion of sugar per ton of cane
	Tons	Per cent	Per cent	Per cent
B. H. 10/12.....	11.8	16.20	84.8	12.53
Mayaguez 3.....	2.0	15.97	85.4	12.40
Mayaguez 42.....	3.3	17.50	88.8	13.85
Mayaguez 49.....	2.4	16.00	86.1	12.47

Mayaguez 42 exceeded B. H. 10/12 in both sucrose and purity, whereas seedlings Nos. 3 and 49 were equal to B. H. 10/12. These figures are of especial interest because they are the results of the first normal-juice analyses of the three seedlings and confirm the results secured in analyses of the hand-milled juices as to the superiority of Mayaguez 42 over Mayaguez 3 in sucrose.

Mayaguez 28 was grown on a dry hillside at Central Coloso in comparison with P. O. J. 2725. This seedling stools better and is more drought resistant than P. O. J. 2725. The area planted with Mayaguez 28 was extended by the station because of these qualities and because of the very high analyses of the hand-milled juices secured during the first two years. A 30-ton lot of Mayaguez 28 gave a normal juice of 20.3 per cent sucrose and a purity of 90.27 per cent, whereas a 42.5-ton lot of P. O. J. 2725 gave a normal juice of 16.22 per cent sucrose and a purity of 84.62 per cent. Central Coloso is planting 150 acres with Mayaguez 28.

The apparent immunity or commercial resistance<sup>7</sup> of Mayaguez seedlings Nos. 3, 7, and 42 to mosaic is well established. Seedlings Nos. 13, 52, and 83 are apparently immune. No mosaic developed in the plats of these seedlings in the 1929 mosaic-elimination test at Mayaguez, and none has been observed in field trials at Santa Rita or at Constancia. A third group of hybrid seedlings, Mayaguez Nos. 28, 44, 49, 61, and 63, are of particular interest, as they continue to confirm data collected in previous years which indicated that mosaic infection was negligible in these varieties, and that little difficulty would be experienced in keeping fields of them rogued for the disease. The policy of the station has, therefore, been changed, and only such seedlings as are very susceptible to mosaic are now discarded.

A survey was made to determine the area under cultivation with Mayaguez seedlings. Most of the large cane plantations near Mayaguez, San German, and Lajas were visited, and also Centrals Coloso, Fajardo, Aguirre, Guanica, Fortuna, Mercedita, Rufina, and San Francisco. The estimated area for the grinding season of 1933 is over 600 acres. Mayaguez 28 leads the rest with 500 acres of land, followed in the order named by Mayaguez seedlings Nos. 42, 7, 49, and 63. All sugar centrals where cooperative trials were made have increased the area planted with Mayaguez seedlings. Central Eureka and Russell & Co., at Hormigueros, have  $\frac{1}{4}$ -acre plats and  $\frac{1}{2}$ -acre plats planted with Mayaguez Nos. 7 and 42. Central Coloso has

<sup>7</sup> A variety of sugarcane which is commercially resistant to mosaic has such a high degree of resistance that roguing is inexpensive or unnecessary.

$\frac{1}{2}$ -acre plats planted with Mayaguez seedlings Nos. 3, 28, 42, and 49, each replicated eight times. Central Aguirre has  $\frac{1}{4}$ -acre plats of Mayaguez seedlings Nos. 3, 7, 42, and 63 planted in comparison with F. C. 916 and B. H. 10/12.

#### TESTS OF INTRODUCED VARIETIES

Working in cooperation with Centrals Coloso, Aguirre, Fajardo, Guanica, Carmen, San Vicente, and Eureka, the station chemist and the station plant breeder collected data on the behavior of P. O. J. 2878. This variety as a rule exceeded B. H. 10/12 in cane production wherever planted in test plats in the same fields. P. O. J. 2878 is being planted extensively where mosaic is the limiting factor, as in the San German and the Anasco valleys. Its juice sometimes has a low purity, defecation is slow, and the stools uproot easily under moderately strong wind. The purity has been satisfactory, however, and defecation normal on red clay soils where drainage is good. Uprooting may be partly overcome by planting in deep furrows, but this is impracticable where drainage is poor, and the practice is to plant in banks.

#### SUMMARY OF WORK

P. O. J. 2878 continues to meet with favor despite its tendency to uproot and the slower rate of defecation of its juice on poorly drained fields. Observations on first ratoons in the mosaic-elimination plats indicate that more than 50 third-year seedlings are apparently immune or highly resistant to mosaic. Preliminary field trials indicate that Mayaguez seedlings Nos. 7, 42, and 63 will compete successfully with B. H. 10/12 in sugar production. The satisfactory sucrose content and negligible mosaic infection of Mayaguez seedlings Nos. 28, 44, 49, and 61 justify their inclusion in field trials more extensively than has been practiced in the past. The area in Mayaguez seedlings has increased from 73 acres in 1930 to over 600 acres in 1931.

#### SWEET CORN

Sweet-corn breeding was carried on with a view to increasing the plant size of Mayaguez 1 by crossing it with native field corn, securing by mass selection an improvement in kernel type and plant vigor over Mayaguez 1, and increasing for distribution the seed supply of the new type thus selected.

Bulked native sweet corn from Mayaguez 1 and selection 27-Su-5 were planted next to a bulked mixture of native field corn that had been collected from all parts of Porto Rico. The object was to secure the vigor of the field corn in combination with the best elements in the native sweet corn. The sweet corn was not detasseled, but was allowed to interpollinate so that ears could be selected for sweet-corn kernel types which would otherwise be obscured where complete pollination by the field corn occurred. Ears were selected from 37 sweet-corn plants bearing deeply shrunken kernels of keystone type. From these ears the first generation hybrid seeds were selected.

Of the first-generation progeny of the cross between Mayaguez 1 sweet corn and the best starchy lines, 100 plants were bagged for pollination. From these 50 self-pollinated ears were secured. Short kernels or those of a flinty type were discarded, and all keystone sweet kernels were bulked together for subsequent work.

In August, 1931, second-generation progenies of the cross Mayaguez 1 and the best starchy lines were grown. Six ear-to-row selections from pure native sweet corn were detasseled and mass pollinated with the second-generation plants. At maturity mass selection was made for keystone type of kernel. There was an apparent improvement in kernel size over Mayaguez 1. Fifty kernels taken from near the bases of the best five ears of the Mayaguez 1 selections were compared with a similar sample from the second-generation plants. The Mayaguez 1 selections had an average kernel length of 9.32 millimeters, as compared with an average kernel length of 10.4 millimeters for the second-generation hybrid seed.

In cooperation with the insular experiment station at Rio Piedras a  $\frac{1}{4}$ -acre plat of sweet corn was grown for distribution under the designation "Mayaguez 3." To constitute this variety, 15 large ear-to-row selections of Mayaguez 1 were pollinated with 20 second-generation ears secured by mass selection from Mayaguez 1 crossed with the best starchy lines. All ears in the increase plat that proved to be off type were rogued out, and the rest were bulked.

Mayaguez 1 sweet corn, distributed to Guillermo Cabrera, was grown under irrigation in the Isabela district on a  $\frac{1}{10}$ -acre plat. The plant growth averaged 5 to 6 feet to tassel base, indicating a satisfactory vigor. Well-formed ears ranging from 4 to 6 inches in length were produced and for table use were considered far superior in flavor to the native field corn. Considerable variation was noticed, however, and the proportion of nubbins was high.

Mayaguez 3 was distributed to 15 corn growers. It has been pronounced superior to Mayaguez 1 in tenderness and in depth of kernel.

#### FIELD CORN

The field-corn work was centered on elimination in inbred lines, increasing the seed supply of the best inbred lines, making first-generation hybrids between inbred lines and corn from various farms, and starting hybrid yield trials.

In September, 1930, 95 lines inbred from two to five generations were planted for comparison with Isabela corn from the farm of Miguel Guevara. The inbred lines were grown in the same hills in close competition with the Guevara corn. Only those lines whose average ear length approximated that of the check corn were retained. Discard was also made on the basis of proportion of marketable ears by weight. Castillear 1-5-1-5-2 was outstanding for plant vigor and large sound kernels. Its proportion of marketable ears was 89.5 per cent, whereas most of the other lines yielded under 70 per cent. Twenty other lines were selected for additional trials. The line outstanding for ear length was Coamo 12-13-1-3-2.

In the spring of 1930, 15 inbred lines were grown under irrigation at Mayaguez for seed increase. Castillear 1-5-1-5-2 again

proved superior to all others in grain quality. The average ear was 15.2 centimeters long by 4.44 centimeters in diameter and was equal in size to those of open-pollinated corn. It is highly desirable for cheap production of first-generation hybrid seed that the pollinator give yields not too inferior to those of ordinary corn, and Castillear 1-5-1-5-2 meets this requirement.

In cooperation with the insular department of agriculture one-fourth of an acre of field corn was grown at the Isabela substation to secure hybrid seed for field tests. Three types, two from farms near Isabela and one from Penuelas, were chosen as representative of lowland corns and used as the pistillate parents. The fifth-generation lines were lumped together to constitute the pollinator, Castillear 1-5-2. These are inbred strains derived from the highest yielding ear-to-row selection thus far tested at Mayaguez. In 1927 the original second-generation line from which these were developed gave an increased yield of 30 per cent when outcrossed with Yauco corn. The names of the three hybrids from the Isabela substation are Mayadilla 2, Mayaguarbe 2, and Mayauelas 2, and are combinations of the word "Mayaguez" and the names of the towns or farms from which the pistillate parent seeds were derived. Nearly 5 bushels of hybrid seed was produced. The most promising pistillate parent was a corn from Aguadilla which yielded at the rate of 45.6 bushels per acre. This is considered a very high yield and demonstrated that, contrary to the prevailing opinion, corn will yield well during the winter season if selected seed is used and the crop is grown under irrigation.

In cooperation with Central Coloso a second breeding plat of one-fourth of an acre of field corn was grown under irrigation near Isabela. For the pistillate parents the corn of 10 farmers was collected from both highland and lowland districts. Four lines inbred for five generations and five lines inbred for two generations were lumped together to constitute the pollinator, Castillear-1. All these lines gave increased yields when they were outcrossed in 1927 and 1928 with Yauco or Lajas corn. Several pounds of seed of each hybrid were secured. Yields were not calculated because of the uneven stand.

Yield test plats for the first-generation hybrids were started in April and in May, 1930, in cooperation with the insular department of agriculture, on 8 farms—4 at Isabela, 3 at Utuado, and 1 at Barranquitas. As a rule, corn which has been produced in the same vicinity, as well as the corresponding pistillate parent, was grown in plats adjoining those of the hybrids.

Preliminary tests for vigor of growth were made at Mayaguez on two of these hybrids in the spring of 1931. Both hybrids produced larger ears and heavier kernels than did the adjoining rows of pistillate parents. The vigorous plant growth of hybrid No. 2½ is shown on the right in Figure 7. On the left is shown the pistillate parent. The hybrid yielded at the rate of 57.8 bushels per acre, or 6 bushels more than the pistillate parent. This difference is not conclusive, owing to the small size of the plats in which the corn was grown. Twenty-five additional hybrids were produced under irrigation at Mayaguez. The pistillate parents were the same open-pollinated corns as those used at Isabela. The staminate parents were two

inbred lines, one from Lajas and the other from Jayuya. The object in making the crosses is to demonstrate that increased yield may be



FIGURE 7.—Increased vigor secured by crossing self-pollinated lines of corn with a farmer's corn. On the left, an unselected open-pollinated corn from the farm of Miguel Guevara, Isabela, and on the right, Mayabela-2, a hybrid between the Guevara corn and Castillear-1-5-2, a self-pollinated corn developed at Mayaguez. Photographed March 1, 1931, when the corn was just beginning to tassel

secured through the use of an inbred line as one parent and an open-pollinated corn as the other parent.

## SUMMARY OF WORK

Elimination was practiced in 95 inbred lines, and the seed supply of the 15 most vigorous lines was increased. In cooperation with the insular department of agriculture and Central Coloso several bushels of first-generation hybrid seed were produced and 13 different hybrids were made. Twenty-five additional hybrids were produced at Mayaguez. In cooperation with the insular department of agriculture, yield trials were started on eight different farms on a total area of 9½ acres.

## REPORT OF THE AGRICULTURIST

By H. C. HENRICKSEN

## CITRUS INVESTIGATIONS

## ROOT DEVELOPMENT

The study of root development in different soils was finished, and the results were published for general distribution.<sup>8</sup> It was shown, among other things, that in clay soils the horizontal spread of the roots is equal to that of the branches. This knowledge was immediately taken advantage of by the planters and is now serving as the basis for the application of fertilizer and irrigation water. It was also shown that in clay soil the feeding roots seldom penetrate much more than 8 inches below the surface and the anchor roots only a few inches deeper. This is especially true of the roots of rough lemon stock. This information is not directly applicable without further data on root development in artificially prepared soil. In order to secure such data an experiment was begun in which adequate drainage to a depth of 4 feet was provided, and the soil was so prepared as to provide different degrees of aeration to that depth. Two-year-old nursery trees were planted in this soil, and some of them will be dug up from time to time so that their root development may be studied.

## PROBABLE FERTILIZER LOSS BY LEACHING

The fairly exact knowledge of the root area of the citrus tree acquired in the study of its root development was used as the basis for an investigation of the probable loss of fertilizer by leaching. Measured soil areas in the field were inclosed by covered frames. Fertilizers were applied within the frames, and measured volumes of water were added from time to time. Soil samples from these areas were analyzed at intervals, and soil samples from outside the frames were used for percolation experiments in the laboratory. From the information thus gained, the probable loss of fertilizer salts, due to leaching, under different amounts of rain, was calculated. The results were published in a mimeographed number of Agricultural Notes.<sup>9</sup>

Incidentally the water-holding capacity of several soil types was determined, and the information obtained will serve as a basis for

<sup>8</sup> Mimeographed number of Agricultural Notes, available copies of which may be had upon application to the director of the station.

<sup>9</sup> Available copies may be had upon application to the director of the station.

estimating the amount of irrigation water to be applied. These data are considered to be of importance in view of the fact that irrigation systems have recently been installed on many plantations.

### PINEAPPLE INVESTIGATIONS

#### NEW VARIETIES

Preparations were made for the production of new varieties of pineapples. Varieties and types are to be introduced from South America for trial in Porto Rico. Seeds of several crosses were received from Hawaii, and germinated well. Propagating introduced material by seeds is advantageous because it eliminates the possible dissemination of insect pests and fungi.

#### CONTROL OF TIME OF BLOOMING

Certain phases of bloom control were studied. Many different chemicals, including acidic, alkaline, and gas-producing chemicals, were dropped into the heart of the pineapple plant, but none of them affected the time of blooming. Calcium phosphate as a fertilizer was tried. Triple acid phosphate supplying 12 grams of  $P_2O_5$  per plant was applied to large plants. This resulted in a cessation of vegetative vigor, visible in the color of the leaves, but failed to affect time of blooming. The fruit produced was smaller, and fewer plants fruited than in the rest of the field where only a very small amount of calcium phosphate was applied in the regular fertilizer. The results confirm those of former experiments, viz, that a fairly large application of calcium phosphate will result in a cessation of plant growth. On the other hand, such cessation of growth can not be relied upon to result in the formation of bloom.

Cutting all the roots on one side of the plant had the same effect as applying calcium phosphate, but was less damaging. The results show conclusively that root pruning can not be relied upon to induce the plants to bloom at any given time.

In the 1930 report mention was made of the fact that the pineapple plant can be induced to bloom by applying smoke to it. The efficiency of this method has been well established, but results of experiments show that plants when so treated produce very few slips. This fact introduces a new problem for investigation during the coming year.

#### BAY-OIL INVESTIGATIONS

The bay tree (*Amomis caryophyllata*; *Pimenta acris*) is grown to a limited extent in certain of the drier districts of the island, and five local distilleries are at present producing bay oil. A problem confronting the industry is how to distinguish bay trees that produce lemon-scented leaves from bay trees that do not produce such leaves. Some such trees can be readily identified when the lemon odor is strong, but others produce leaves that are only slightly lemon scented. The least scent is objected to by the bay-oil industry. A method was found for chemically detecting minute quantities of aldehyde in the leaves. The well-known fuch sine reagent is used for the purpose, and the method of application is so simple that any grower can readily survey his plantation at small cost in order to detect and

eliminate undesirable trees. The method was described in a mimeographed number of Agricultural Notes.<sup>10</sup>

A preliminary study of the yield and quality of oil in relation to type of tree, maturity of leaf, and soil and climatic conditions, was made. The results of this work indicate some of the problems that affect the industry as a whole. A continuation of the work seems to promise results that will be of great benefit to the industry.

#### FRUIT GROWERS' ORGANIZATIONS

In former years the agriculturist was active in assisting fruit growers to organize and in helping the organizations to accomplish the work for which they were formed. The necessity for such assistance has been lessening year by year. Shipping problems are being solved by a central committee, and grading is being taken care of by another branch of the United States Department of Agriculture, thus relieving the agriculturist of nearly all work except that pertaining to the production of fruit. Two luncheon meetings were held during the year at which the agriculturist discussed problems not related to production. Field meetings are held when it seems to be desirable to demonstrate the results of field investigations, either at the time the work is in progress or after it is finished. Two such field meetings were held during this year, and both were well attended.

#### MISCELLANEOUS NOTES

Samples of soil, spray materials, irrigation water, and plant and fruit specimens were brought to the agriculturist by planters almost weekly and were examined to the extent found to be necessary in formulating the advice required.

Much interest was manifested in the freezing of fruit juices and pulp. This matter has been under investigation for several years, and much assistance has been rendered to several private parties from time to time. As a result of the accumulated knowledge, a report on fruit beverages for home consumption was prepared by the agriculturist and by the chemist in charge of the local laboratory of the Food and Drug Administration of the United States Department of Agriculture, for distribution at one of the fruit growers' meetings.

#### REPORT OF THE PARASITOLOGIST

By H. L. VAN VOLKENBERG

##### GENERAL SURVEY

On account of the unusually dry weather the year ended June 30, 1931, was favorable for young livestock because fewer parasites attacked them. Notwithstanding the scarcity of good forage, the young cattle in the vicinity of Mayaguez are in better condition than they have been in several years. At the station it was not found necessary to dose calves for stomach worms. The amount of infestation was very slight, comparing favorably with that of other years when monthly treatments were regularly administered.

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<sup>10</sup>Available copies may be had upon application to the director of the station.

The effect of the dry season on liver-fluke infestation was studied, especially in young cattle that were slaughtered at the abattoir. There was very little reduction in the number of these parasites as compared with their prevalence in past years. The proportion of livers condemned because of infestation with this parasite was about the same as in previous years. Grass taken from the margins of a previously infested drainage ditch that had been dry for six months, when experimentally fed to calves caused them to become infested with the liver fluke. This indicates that under natural conditions the encysted stage of the parasite on grass is resistant to drought and remains ineffective for several months at least. In another case a badly infested pasture was drained in order to prevent the propagation of the snail host. However, calves which later were placed in this pasture picked up the infestation. It appears that, to be immediately effective, such control measures as drainage or the use of chemicals that destroy the snails, should be accompanied by plowing of the land to enable grass free from encysted flukes to grow.

#### EXTERNAL PARASITES

The cattle tick, of which there are two varieties, is the most serious external parasite found in Porto Rico. It is found throughout the island, but except during a short period is less common in the dry regions.

Of several other kinds of ticks found, only three are of economic importance. The spinose ear tick is common, attacking cattle, horses, and goats. The tropical horse tick attacks horses, and has also been found in the ears of hogs. The brown dog tick is also common.

The horn fly is the most serious of the insect pests. It is found throughout the island except at the higher elevations. It occurs in myriads in the dry regions and in these localities is more serious than the cattle tick. Nothing is being done to combat or control the horn fly.

The stable fly is also very abundant. In the vicinity of Mayaguez it is about as common as the horn fly. In the country away from the towns the stable fly is often more common in houses than is the house fly. The stable fly as well as most of the other kinds of flies thrive throughout the year.

The larvæ or maggots of the screw-worm fly are very common in wounds in cattle, horses, and swine. Every open wound, unless it is coated with pine tar, is subject to infestation.

The larvæ or bots of the horse botfly have been found in the stomachs of horses and mules.

The larvæ of the ox-warble fly are seen every year on introduced cattle, but apparently the fly is unable to establish itself here. However, precautions should be taken to destroy the larvæ.

A deer fly (*Chrysops costatus*) is the most common species of the family of Tabanidæ found on the horse. This fly is found in the lowlands in shady places near water. At the station its favorite habitat is a mango orchard. Several species of tabanids or horse-flies have been found. One of them is apparently becoming a serious pest in the Lajas district. At least it was more abundant there during the present season.

Goats and poultry are often heavily infested with lice. The goat is usually infested with a biting or a sucking louse and often with both. Several species of lice have been found on poultry. A large sucking louse is common on cattle. The large hog louse has been found only infrequently on hogs that were confined in pens, and is rarely found on the native pig.

The fleas, including the dog, cat, human, and rat fleas, attack animals and man. The sand flea (*Tunga penetrans*) attacks swine and man, and the hen flea attacks poultry. Fleas, especially dog fleas, are usually found on the mongoose. This is the only parasite of this animal, either external or internal, that can definitely be reported thus far.

The mites are of considerable importance. The poultry mite is as common and as injurious here as it is elsewhere. The larvæ of a harvest mite attack horses, especially about the face and head.

Sarcoptic mange has been found in horses and dogs, psoroptic mange in horses and cattle, demodectic mange in swine, cattle, and dogs, and scaly legs in fowls. Demodectic mange is not uncommon in swine. Mange has not been found in the goat. It is more common in horses, especially those kept in towns for trucking, than in other domestic animals.

A skin infection, which somewhat resembles mange, is found on introduced cattle and on crosses with the improved breeds, except the Holstein. The infection attacks the top of the neck, the top line, the tail, and sometimes the hind legs, and causes considerable irritation. It is apparently caused by a fungus. This infection can readily be controlled by applying a dilute solution of formalin to the affected parts.

Other external parasites of animals, either less troublesome or having an importance not perfectly understood, are mosquitoes, buffalo gnats, the "mimes" (*Hippelates texanus*), and leeches that are abundant in swampy land.

Several diseases or abnormalities are ascribed to attacks from external parasites. One is a pathological condition of the horns. It is called "comejen," and is found commonly in oxen and occasionally in dairy cattle. The horn becomes brittle, develops cracks and crevices near the base, and breaks easily. A broken horn destroys the value of the ox as a work animal. Examination of many broken horns failed to show an infection by parasites or by bacteria. The only explanation of the condition that can be offered is that the blood vessels supplying the matrix of the horn become constricted by the thong that is wound around the base of the horns to attach the yoke. Thus, the nourishment of the horn is reduced, and its tone or condition is lowered. In dairy cattle the same effect may be caused by the stakes and tie ropes that are in constant use.

*Dermatitis solaris* of cattle in its early stages is sometimes mistaken for mange. (Fig. 8.) This dermatitis has been found only on the Holstein and Ayrshire breeds. Only the white or white-spotted areas of the skin on the back are affected. This trouble begins with a local congestion of the skin, followed by the formation of scales and pustules. The pustules may heal, causing a thickening of the skin or the formation of horny excrescences, or they may coalesce, resulting in necrosis and the formation of scabs. This dermatitis

may persist indefinitely without spreading and without affecting the condition of the animal, but is very unsightly and may result in a fatal secondary infection. The dermatitis is caused by the sun acting upon the white areas of the skin, especially of animals having a local albinism or pinkish unpigmented areas of skin.



FIGURE 8.—Advanced stage of dermatitis (*Dermatitis solaris*) of cattle caused by the direct rays of the sun which act only upon white-haired areas on the back

#### A NEW HOST OF THE THORNY-HEADED WORM OF SWINE

The water beetle (*Tropisternus collaris*) is an intermediate, and in Porto Rico an apparently important host of the thorny-headed worm (*Macracanthorhynchus hirudinaceus*) of swine. Pigs often feed on the roots of water plants in swamps. Thus, they have opportunity to swallow these beetles. The beetle becomes sluggish after infestation and thus is less able to escape the pigs. In the laboratory care must be used in limiting the amount of infestation, otherwise the beetle will not survive.





